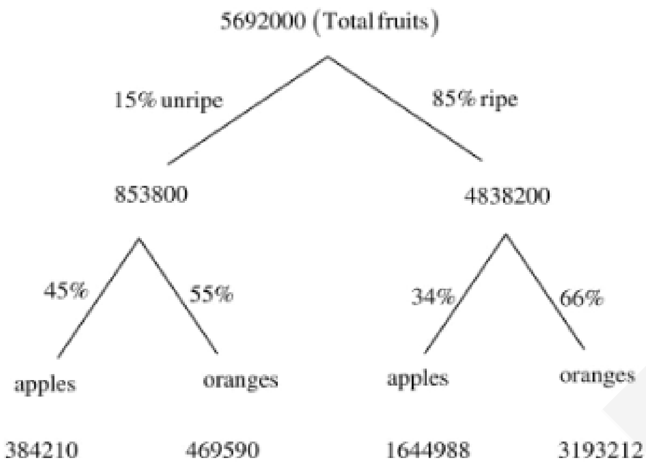
1. Ans. A.
Before superlative article 'the' has to be used. 'one of' the expression should take plural noun and so option 'C' and 'D' can't be the answer.

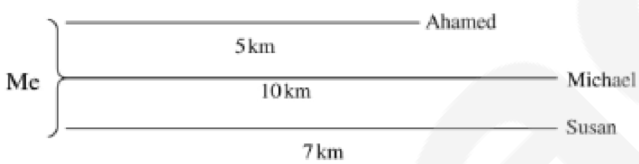
2. Ans. B.
'lose' is verb.

3. Ans. A.
'effectiveness' is noun and 'prescribed' is verb. These words are apt and befitting with the word 'medicine.'

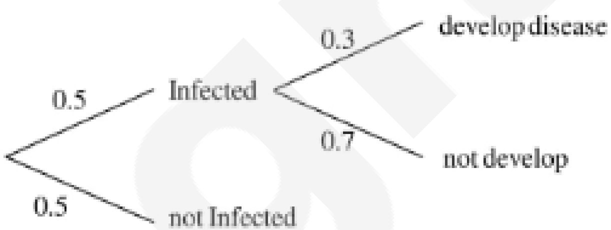
4. Ans. A.



5. Ans. C.



6. Ans. C.



P (a person infected but does not show symptoms) = 0.50 x 0.70 = 0.35
The percentage is 35%

7. Ans. B.
The words 'was confident that they would reciprocate' and 'last week proved him wrong' lead to statements iii and iv as logically valid inferences.

8. Ans. D.
From given data, the following arrangement is possible Shiva Leela Pavithra Among four alternatives, option D is TRUE.

9. Ans. C.

$$q^{-a}=\frac{1}{r},r^{-b}=\frac{1}{s},s^{-c}=\frac{1}{q}$$
$$q^{a}=r,r^{b}=s,s^{c}=q$$
$$r=q^{a}=(s^{c})^{a}=s^{ac}$$
$$s=r^{b}=(s^{ac})^{b}=s^{abc}\Rightarrow abc=1$$

10. Ans. C.

Q's one hour work = $\dfrac{1}{25\times 12}$

R's one hour work = $\dfrac{1}{50\times 12}$

Since Q has taken 2 days sick leave, he has worked only 5 days on the end of seventh day.

Work completed by Q on 7th day= (5x12) $\dfrac{1}{25\times 12}$

Work completed by R on 7th day=(7x18) $\dfrac{1}{50\times 12}$

Ratio of their work

$$=\frac{5\times 12}{25\times 12}/\frac{7\times 12}{50\times 12}\Rightarrow 20:21$$

11. Ans. C.

$$M.M^{4k+1}=M^{4K}.M^{2}\left(M^{4}\right)^{k}.M^{2}=I.M^{2}=M^{2}$$
A *is not correct*
$$M.M^{4k+2}=M^{4K}.M^{3}\left(M^{4}\right)^{k}.M^{3}=I.M^{3}=M^{3}$$
B *is not correct*
$$M.M^{4k+3}=M^{4K}.M^{4}\left(M^{4}\right)^{k}.M^{4}=I.I=I$$
C *is correct*
$$M.M^{4k}=M.\left(M^{4}\right)^{k}=M\left(I\right)=M.$$
D *is not correct*

12. Ans. A.
We know that if X is parameter of poison's distribution

Then, First moment $=\lambda$

Second moment $=\lambda^{2}+\lambda$

Given that $\lambda^{2}+\lambda=2$

$$\Rightarrow \lambda^{2}+\lambda-2=0$$
$$(\lambda+2)(\lambda-1)=0$$
$$\lambda=-2 \text{ or } 1 \qquad (\lambda\neq -2)$$
$$\therefore \lambda=1$$
$\therefore$ *First moment* $=1$

13. Ans. B.
We know that every differentiable function is continuous but converse need not be true

14. Ans. A.

15. Ans. C.
Since the integration of an odd function is even in this logic A and B cannot be the answer as they are odd functions.
However both C and D are even functions but the integration of a linear curve has to be parabolic in nature and it cannot be a constant function. Based on this Option C is correct.

16. Ans. C.
If the input to a system is its eigen signal, the response has the same form as the eigen signal

17. Ans. B.
Consider x (t) = $cos\left(w_0 t\right)$
If x (t) is sampled with a sampling period
T_s, $x\left[n\right]=cos\Omega_0 n$ is obtained

Here, $\dfrac{\Omega_0}{T_s}=\omega_0$

$$\frac{2\pi m}{N_0 T_s}=\frac{2\pi}{T_0}$$

$\therefore \dfrac{T_0}{T_s}=\dfrac{N_0}{m}$ Which must be a rational number

Thus, $\dfrac{T}{T_s}=\dfrac{12}{10}=\dfrac{6}{5}$ lives a periodic signal after sampling.

18. Ans. B.
$$a^n u\left[n\right];ROC:\left|z\right|>\left|a\right| \ =R_1$$
$$b^n u\left[n\right];ROC:\left|z\right|>\left|b\right|=R_2$$
$$a^n u\left[n\right]+bnu\left[n\right];ROC:R_1\cap R_2=\left|z\right|>\left|b\right|$$

19. Ans. D.
A two port network is reciprocal in transmission parameters if AD – BC = 1 i.e. Determinant(T) = 1

20. Ans. A.
Sinusoidal signal frequency = 33
Impulse train frequency = 46
Resultant signal contains spectral frequencies ±33, ±13, ±7.9, ±59etc,
Thus if it is passed through ideal LPF of cutoff frequency 23Hz only ±13Hz frequency is filtered out.
Output signal fundamental frequency = 13 Hz.

21. Ans. A.
New energy level is near to conduction band, so it is pentavalent atoms to form n-type semiconductor.

22. Ans. C.
$$\rightarrow I\infty\frac{1}{L}soL\downarrow I_{OFF}\uparrow$$
$$\rightarrow r_d=\frac{\partial V_{DS}}{II_D}=\frac{L}{\mu_n c_{ox}W(V_{us}-V_t-V_{DS})}$$
$$soL\downarrow I_{ON}\downarrow$$
→ If the channel length reduces, then threshold voltage also changes
$$\rightarrow L\downarrow I_{ON}\downarrow$$
So option C. is matching.

23. Ans. B.
Voltage at (+) terminal $V_+=V_{CC}-V_{ref}$

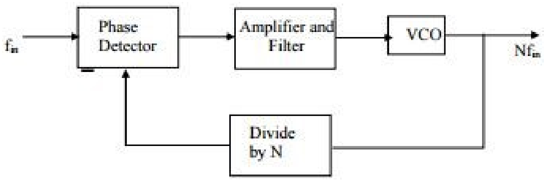
Voltage at emitter of PNP BJT $V_E=V_{CC}-V_{ref}$

The current I_E through R
$$I_E=\frac{V_{CC}-(V_{CC}-V_{ref})}{R}$$
$$I_E=\frac{V_{ref}}{R}$$
$$I_C=I_0$$
$$I_C=\alpha I_E=(\frac{\beta}{\beta+1})I_E\Rightarrow\boxed{I_C=I_0(\frac{\beta}{\beta+1})\frac{V_{ref}}{R}}$$

24. Ans. A.
The voltage at (-) terminated of the OP-Amp
$$V_{(-)}=\frac{2}{2+8}\times 10=2V$$
The output of the op-Amp goes to $+V_{cc}$ whenever $V_i>V_{(-)}i.e\ V_i>2V$ makes BJT turn ON. So, the LED glows. The sections of the wave form become more than 2V for the range [a to b, (c to d) and (e to f)] So LED glows 3 times.

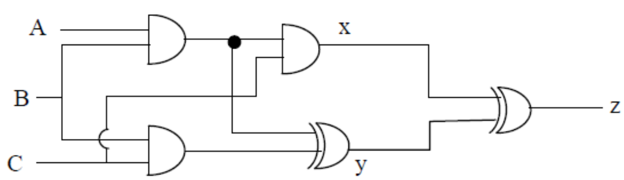
25. Ans. A.
Sol. When the output voltage is positive the diode D_i is turned on making $100k\Omega$ resistor to become parallel to $22.1k\Omega$. So the gain is reduced. When the output voltage becomes negative the diode D_2 is turned on thereby again $100k\Omega$ resistor to become parallel to $22.1k\Omega$. So the gain is reduced. With the use of diodes, the non-ideal OP-Amp is made stable to produce steady

26. Ans. A.



f_{in}	Divide by N	VCO output(Nf_{in})
5kHz	2	10kHz
5kHz	4	20kHz
5kHz	8	40kHz
5kHz	16	80kHz

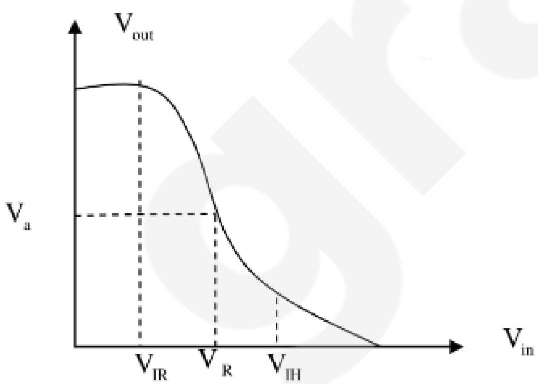
27. Ans. C.



$$x = \sum m(7)$$
$$y = \sum m(3,6)$$
$$z = \sum m(3,6,7)$$
$$= \overline{A}BC + AB\overline{C} + ABC$$
$$= \overline{A}BC + AB$$
$$= B(\overline{A}C + B)$$
$$= B(A + c)$$

28. Ans. C.

The transfer characteristics of the CMOS inverter is as follows

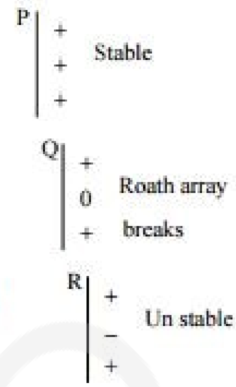


Since the inverter is connected in feedback loop formed by connecting 1OXQ resistor between the output and input, the output goes and stays at the middle of the characteristics

$$V_a = \frac{V_{IR} + V_{IH}}{2}$$

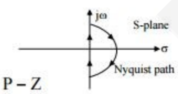
$V_a \Rightarrow$ Switching threshold of inverter

29. Ans. D.



X – P, Y – R, Z – Q

30. Ans. A.



N = P – Z

For closed loop stability Z = 0, N = P

∴ (−1, j0) should be encircled in Counter clock wise direction equaling P poles in RHP.

31. Ans. B.

$R_b = 56$ kbps, $\alpha = 0.25$

$$BW = \frac{R_b}{2}[1+\alpha] = \frac{56}{2}[1+0.25]\text{kHz} = 35 \text{ kHz}$$

32. Ans. B.

33. Ans. B.

$$s(t) = 5\, cos 1600\pi t$$
$$+20\, cos 1800\pi t + 5 cos 2000\pi t$$
$$= A_c[1 + \frac{A_m}{A_c}\cos 200\pi t]\cos(1800\pi t)$$
$$A_c = 20$$
$$\frac{A_c\mu}{2} = 5 \Rightarrow \mu = \frac{5\times 2}{20} = 0.5$$
$$\boxed{\mu = 0.5}$$

34. Ans. A.

Consider a Gaussian surface a sphere of radius 10m

To ensure $\vec{D} = \vec{0}$ at radius 10m, the total charge enclosed by Gaussian surface is zero

$$Q_{enc} = 0$$
$$20 \times 2^2 - 4 \times 4^2 = P_s \times 8^2 = 0$$
$$\Rightarrow P_s = -0.25 nc / m^2$$

35. Ans. B.

Given

Propagation contact, $P = (2 + j5)\ m^{-1}$,

characteristic impedance $z_0 = 50\ \Omega$,

angular frequency $\omega = 10^6$ rad/sec,

$$P = \sqrt{(R + j\omega L)(G + j\omega C)}$$

$$z_0 = \sqrt{\frac{(R + j\omega L)}{(G + j\omega C)}}$$

$$Pz_0 = R + j\omega L$$

$$\Rightarrow R + j\omega L = (100 + j250)$$

$$\therefore\ R = 100\ \Omega/m$$

$$L = \frac{250}{10^6} = 250\,\mu H/m$$

$$\frac{P}{z_0} = G + j\omega C$$

$$G + j\omega C = \left(\frac{2}{50} + j\frac{5}{50}\right)$$

$$\therefore G = 0.04\ s/m$$

$$C = \frac{5}{50\times10^6} = 0.1\,\mu F/m$$

Therefore line constants L, C, R & G are respectively $L = 250\ \mu H/m$, $C = 0.1\ \mu F/m$, $R = 100\ \Omega/m$, $G = 0.04\ s/m$

36. Ans. B.

Method-I:-

$$= \frac{1}{2\pi}\int_{x=-2}^{2}\int_{y=-\sqrt{4-x^2}}^{\sqrt{4-x^2}}(x+y+10)\,dxdy$$

$$= \frac{1}{2\pi}\int_{-2}^{2}\left[2\int_{0}^{\sqrt{4-x^2}}(x+10)+0\right]dx$$

$$= \frac{1}{2\pi}\int_{-2}^{2}(x+10)(y)_0^{\sqrt{4-x^2}}\,dx$$

$$= \frac{1}{\pi}\int_{-2}^{2}(x\sqrt{4-x^2}+10\sqrt{4-x^2}\,dx$$

$$= \frac{1}{\pi}\left[0+10\times2\int_{-2}^{2}\sqrt{4-x^2}\,dx\right]$$

$$= \frac{20}{\pi}\left[\frac{x}{2}\sqrt{4-x^2}+\frac{4}{2}\sin^{-1}\left(\frac{x}{2}\right)\right]_0^2$$

$$= \frac{20}{\pi}\left[0+2\left(\frac{\pi}{2}\right)\right] = 20$$

Method – II:-

$$\frac{1}{2\pi}\iint_D (x+y+10)\,dxdy$$

$$= \frac{1}{2\pi}\int_{r=0}^{2}\int_{\theta=0}^{2\pi}[r(\cos\theta+\sin\theta)+10]r\,dr\,d\theta$$

(Changing into polar coordinates by $x = r\cos\theta$)

37. Ans. A.

$$\begin{bmatrix} x(n) \\ x(n-1) \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}^n \begin{bmatrix} 1 \\ 0 \end{bmatrix}, n \geq 2$$

n = 2

$$\begin{bmatrix} x(2) \\ x(1) \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}^2 \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 2 & 1 \\ 1 & 1 \end{bmatrix}\begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$$

x(2) = 2, x(1) = 1

n = 3

$$\begin{bmatrix} x(3) \\ x(2) \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}^3 \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 3 & 2 \\ 2 & 1 \end{bmatrix}\begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 3 \\ 2 \end{bmatrix}$$

x(3) = 3, x(2) = 2

From the above values we can write the recursive relation as

x(n) = x(n–1) + x(n –2)

x(2) = x(1) + x(0) = 1 +1 = 2

x(3) = x(2) + x(1) = 2 +1 = 3

x(4) = x(3) + x(2) = 3 + 2 = 5

x(5) = x(4) + x(3) = 5 + 3 = 8

x(6) = x(5) + x(4) = 8 + 5 = 13

x(7) = x(6) + x(5) = 13+ 8 = 21

x(8) = x(7) + x(6) = 21 + 13 = 34

x(9) = x(8) + x(7) = 34 + 21 = 55

x(10) = x(9) + x(8) = 55 + 34 = 89

x(11) = 89 + 55 = 144

x(12) = 144 + 89 = 233

38. Ans. A.

$$-\frac{1}{2\pi}\oint_c \frac{\sin z}{(z-2\pi j)^3}dz = -\frac{1}{2\pi}\times 2\pi j\times\frac{f''2\pi j}{2!}$$

(by Cauchy integral formula)

$$f(z) = \sin z$$

$$f'(z) = \cos z$$

$$f''(z) = -\sin z$$

$$-\frac{1}{2\pi}\oint_c \frac{\sin z}{(z-2\pi j)^3}dz =$$

$$-\frac{1}{2\pi}\times 2\pi j\times\left(\frac{-\sin 2\pi j}{2}\right) = -\frac{1}{2}\sinh 2\pi$$

$$= -133.87$$

39. Ans. A.

Volume= $\int_{3}^{5}\int_{\pi/8}^{\pi/4}\int_{3}^{4.5} \rho d\rho d\phi dz = 4.71$

40. Ans. B.

Sol. Laplace transition of one cycle of

$f(t) = \frac{1}{S}\left[1 - e^{-s_r/2}\right]$

$\therefore$ Laplace transition of causal periodic square wave given in f(t) is,

$$F(s) = \frac{\frac{1}{s}\left[1-e^{-ST/2}\right]}{(1-e^{-ST})}$$

$$= \frac{\frac{1}{S}\left[1-e^{-ST/2}\right]}{\left[1-e^{-ST/2}\right]\left[1+e^{-ST/2}\right]} = \frac{1}{S\left[1+e^{-ST/2}\right]}$$

41. Ans. A.

The property of any LTI system or network is if the excitation contains 'n' number of different frequency then the response also contains exactly n number of different frequency term and the output frequency and input frequency must be same however depending on components there is a possible change in amplitude and phase but never the frequency.

$\rightarrow$ If the source has 3 frequency terms as given

$$\sum_{k=1}^{3} a_k \cos k\omega_0 t$$

b_k *and* $\phi_k t \;\geq\; 01 - e^{-t/T}$

$t - T\left(1 - e^{-t/T}\right)$

$$Y(s) = \frac{K}{s^2(1+s^2)} = \frac{K_1}{s} + \frac{K_2}{s^2} + \frac{K_3}{1+s\tau}$$

$$Y(t) = K_1 u(t) + K_2 u(t) + K_3 e^{-t/2}$$

$\rightarrow X - R$

$Y - P$

$Z - Q$

$$\left(1 - e^{-t/\tau}\right) X(s) = \frac{k}{1+s\tau}1$$

$\Rightarrow y(t) = ke^{-t/\tau}$

then any voltage or any current of any element should have also 3 terms based on this option B. and D. are eliminated.

$\rightarrow$ If we take option C.. It has 3 frequency term but it also suggest there is a phase change so 4„ but amplitude must be same as input as ak is present which may not be true always.

$\rightarrow$ So option A. is correct, as it suggest frequency term of output and inputs are same with possible change in amplitude and phase, because we have (b_k *and* ϕ_k).

42. Ans. C.

$\rightarrow$ In general the first order, L.P.F filter transfer function is $G(s) = \frac{k}{1+s\tau}$ because G(0) = k and G (co) = 00, if we take this transfer function as reference and give different input such as s(t).r(t).u(t)

$\rightarrow$ if input is s(t)

$$Y(s) = \frac{k}{1+s\tau} X(s) = \frac{k}{1+s\tau}1$$

$\Rightarrow y(t) = ke^{-t/\tau}$

$\rightarrow$ if input is u(t)

$$Y(s) = \frac{k}{1+s\tau} = K_1\left(1 - e^{-t/\tau}\right)$$

$\rightarrow$ if input is r(t)

$$Y(s) = \frac{K}{s^2(1+s^2)} = \frac{K_1}{s} + \frac{K_2}{s^2} + \frac{K_3}{1+s\tau}$$

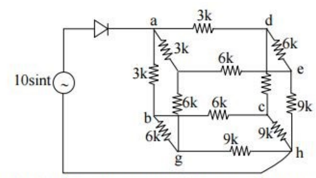
$$Y(t) = K_1 u(t) + K_2 u(t) + K_3 e^{-t/2}$$

$\rightarrow X - R$

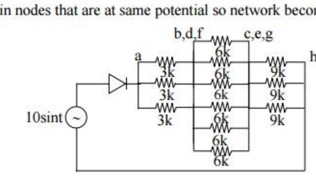
$Y - P$

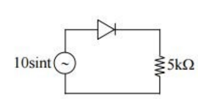
$Z - Q$

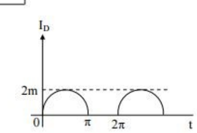
43. Ans. A.



We can join nodes that are at same potential so network becomes





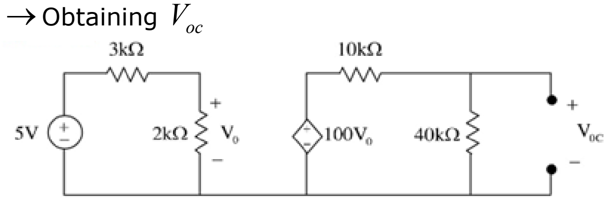


$I_{D(RMS)} = \frac{2m}{2} = 1mA$

44. Ans. C.

To find maximum power transferred to load we need to obtain Thevenin equivalent of the circuit

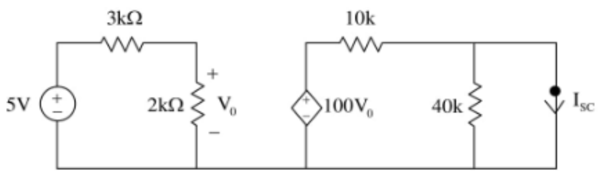
$\rightarrow$ Obtaining V_{oc}



$$V_0 = \frac{2}{3+2}5 = 2V$$

$$V_{0C} = \frac{40}{10+40}100V_0 = \frac{4}{5}\times 100\times 2 = 160V$$

$\rightarrow$ Obtaining I_{SC}

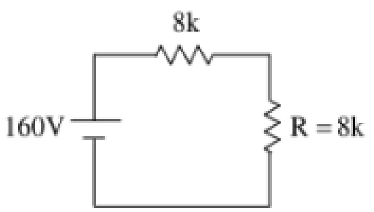


$$V_0 = \frac{2}{3+2}5 = 2V$$

$$I_{SC} = \frac{100V_0}{2} = \frac{200}{10} = 20mA$$

$$\rightarrow R_m = \frac{V_{0C}}{I_{SC}} = \frac{160}{20} = 8k\Omega$$

$\rightarrow$ So the network is



$\rightarrow$ For MPTR = 8k

$$P_{mcr} = \frac{V_{+n}^2}{4R_{+n}} = \frac{160^2}{(4\times 8)\times 103} = 0.8watt.$$

45. Ans. A.

Consider

$$\frac{1}{\pi}\int_{-\pi}^{\pi} X(e^{j\omega})\sin^2(2\omega)d\omega$$

$$= \frac{1}{\pi}\int_{-\pi}^{\pi} X(e^{j\omega})\left(\frac{1-\cos 4\omega}{2}\right)d\omega$$

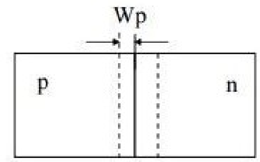
$$= \frac{1}{\pi}\int_{-\pi}^{\pi} X(e^{j\omega})\sin^2 d\omega - \frac{1}{2\pi}\int_{-\pi}^{\pi} X(e^{j\omega})\cos 4\omega d\omega$$

$\frac{1}{2\pi}\int_{-\pi}^{\pi} X(e^{j\omega})\cos 4\omega d\omega = 0$ For the given x[n]

$$\because \frac{1}{2\pi}\int_{-\pi}^{\pi} X(e^{j\omega})d\omega = x[0]$$

$$\frac{1}{\pi}\int_{-\pi}^{\pi} X(e^{j\omega})\sin^2 2\omega d\omega = 8$$

46. Ans. A.



$\varepsilon = 12\varepsilon_0$

$= 12\times 8.85\times 10^{-14}$F/m

$N_D = 10^{16}\text{cm}^{-3}$

$= 10^{22}\text{m}^{-3}$

$N_A = 10^{17}\text{cm}^{-3}$

$= 10^{23}\text{m}^{-3}$

$$V_0 = \frac{kT}{q}\ell n\left[\frac{N_A N_D}{ni^2}\right] = 0.026\ell n\left[\frac{10^{23}\times 10^{22}}{(1.5\times 10^{16})^2}\right] = 0.757\text{V}$$

$$W = \sqrt{\frac{2\varepsilon}{q}V_0\left(\frac{1}{N_A}+\frac{1}{N_D}\right)} = \sqrt{\frac{2\times 12\times 8.85\times 10^{-14}}{1.6\times 10^{-19}}\times 0.757\left(\frac{1}{10^{23}}+\frac{1}{10^{22}}\right)}$$

$= 3.325\times 10^{-8}$m

$= 3.325\times 10^{-6}$cm

$$W_p = \frac{N_D}{N_A+N_D}\omega = \frac{10^{22}}{10^{22}+10^{23}}\times 3.325\times 10^{-8} = 3.023\times 10^{-9}\text{ m}$$

$= 3.023\times 10^{-7}$cm

$Q = W_P N_A eA$

$$\Rightarrow \frac{Q}{A} = W_p N_A e = 3.023\times 10^{-7}\times 10^{17}\times 1.6\times 10^{-19}$$

$= 4.836\times 10^{-9}\text{cm}^{-2}$

$= 4.836\text{nc-cm}^{-2}$

47. Ans. A.

IDs =

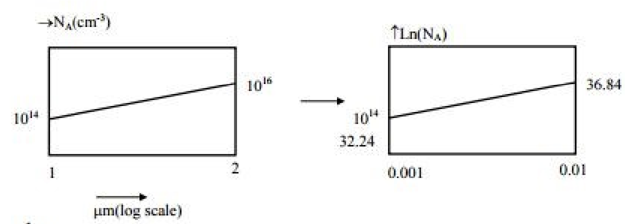
$$I_{DS} = \frac{1}{2}\mu_N C_{OX}\frac{W}{L}(V_{GS}-V_T)^2(1+\lambda V_{DS})$$

$$g_{dS} = \frac{dI_{DS}}{dV_{DS}} = \lambda\frac{1}{2}\mu_N C_O\times\frac{W}{L}(V_{GS}-V_T)^2$$

$$= 0.09\times\ 0.5\ \times 70\ \times 10^{-6}\times 4(1.8-0.3)^2$$

$$= 28.476\mu s$$

48. Ans. B.



$$qD_p\frac{dp}{dx} = q\mu_p p\varepsilon$$

$$\mu_p V_T\frac{dp}{dx} = \mu_p p\varepsilon$$

$$\varepsilon = \frac{V_T}{p}\frac{dp}{dx} \qquad p \cong N_A$$

$$\varepsilon = \frac{V_T}{N_A}\frac{dN_A}{dx} \quad \Rightarrow \varepsilon = V_T\frac{d}{dx}\ln[N_A(x)]$$

$\log_{10} x_1 = 1\mu\text{m} \Rightarrow x_1 = 10^1\ \mu\text{m} = 0.001$ cm

$\log_{10} x_2 = 2\ \mu\text{m} \Rightarrow x_2 = 10^2\ \mu\text{m} = 0.01$ cm

$\ln(10^{14}) = 32.23$

$\ln(10^{16}) = 36.84$

$$\varepsilon = 0.026\left[\frac{36.84-32.23}{0.01-0.001}\right] = 0.0133\text{ /cm}$$

49. Ans. A.

$$P_{n0} = \frac{n_i^2}{N^D} = \frac{2.25\times10^{20}}{5\times10^{16}} = 0.5\times10^4 / cc$$

$$\rightarrow \Delta P = G\tau_{po} = 1.5\times10^{20}\times10^{-6}\times0.1$$

$$= 1.5\times10^3 / cc$$

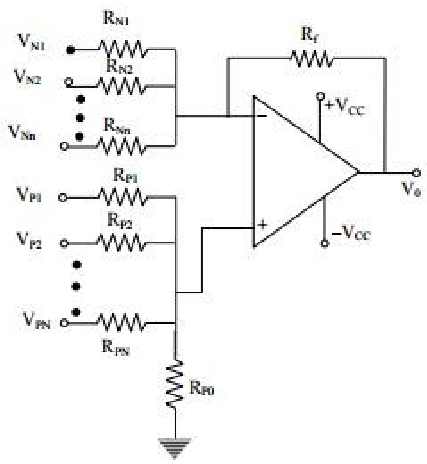
$$\Delta P(t) = \Delta P e^{-t/\tau_p}$$

$$P(t) = \Delta P(t) + P_{no} \approx \Delta P(t)$$

$$\Delta P(0) = \Delta P = 1.5\times10^3 / cc$$

$$\Delta P(t=3) = 7.47\times10^{11} / cc$$

50. Ans. A.



Using superposition it can shown that the output

$$V_0 = \left[1+\frac{R_f}{R_N}\right]\left[\frac{R_p}{R_{p1}}V_{p1} + \frac{R_p}{R_{p2}}V_{p2} + \dots\dots\dots \frac{R_p}{R_{PN}}V_{pn}\right] - \left[\frac{R_f}{R_{N1}}V_{N1} + \frac{R_f}{R_{N2}}V_{N2} + \dots\dots\dots \frac{R_f}{R_{Nn}}V_{Nn}\right]$$

Where $R_N = R_{N1}||R_{N2}||\dots..||R_{Nn}$ and $R_p = R_{p1}||R_{p2} \dots.. R_{PN}||R_{PO}$

In the problem given

$R_f = R_{N1} = R_{N2} = \dots\dots = R_{Nn} = 10k\Omega$

$R_{p1} = R_{P2} = R_{P3} = \dots\dots = R_{PN} = R_{PO} = 1k\Omega$

$$\therefore V_0 = \left[1+\frac{10k}{\left(\frac{10k}{n}\right)}\right]\left[\frac{\frac{1k}{(1+n)}}{1k}V_{P1} + \frac{\left(\frac{1k}{1+n}\right)}{1k}V_{P2} + \dots\dots\right] - \left[\frac{10k}{10k}V_{N1} + \frac{10k}{10k}V_{N2} + \dots\dots\right]$$

$$\therefore V_0 = (V_{P1} + V_{P2} + \dots\dots V_{Pn}) - (V_{N1} + V_{N2} + \dots\dots\dots\dots V_{Nn})$$

If the series approaches ∞ then

$$V_0 = \left(1+\frac{1}{3}+\frac{1}{5}+\frac{1}{7}\dots\dots\right) - \left(\frac{-1}{2}\frac{-1}{4}\frac{-1}{6}-\dots\dots\dots\right)$$

$$= 1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\dots\dots$$

$$= \infty$$

This series is called harmonic series which is a divergent infinite series

$\therefore V_0 = +\infty = +V_{sat} = +V_{CC} = +15V$

51. Ans. D.

The photo diode with Responsivity 0.8A/W

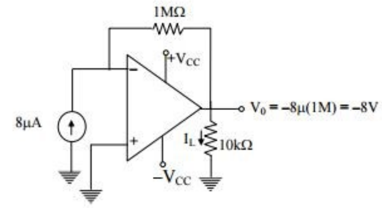
$\therefore$ Diode current $= 0.8A/W[10\mu W]$

$= 8 \times 10^{-6}A$

$V_0 = -8\mu\ (1M) = -8V$

$$I_L = \frac{-8}{10k} = -8\times10^{-4}A = -800\times10^{-6}A$$

$$= -800\mu A$$



Therefore the value of photo current throughput the load is –800 μA

52. Ans. A.

As we know in a decoder w.r.t any binary input combination the corresponding output pin is high and remaining low.

→ Similarly to the encoder one input is high among all and its equivalent binary combination is available at output.

→ In this case to identify the functionality, let give some arbitrary binary input and observe the output.

→ Let [X_2 X_1 X_0] is [1 0 1] respectively then OP_5 = 1 = IP? Then [Y_2 Y_1 Y_0] is [1 0 1]

If [X_2 X_1 X_0] is [1 1 1] then [OP_7 = IP_5 = 1] so [Y_2 Y_1 Y_0= 101] [X_2 X_1 X_0] is [1 0 0] then [OP_4 = IP_6 = 1] so [Y_2 Y_1 Y_0= 110]

→ From the above we can say that

If input 101 then output is 101

101 101

110 110

So input binary and output gray.

53. Ans. B.

Decoder inputs will behaves as MUX select lines and when the output of decoder is high then only corresponding buffer will be enable and passed the inputs (P,Q,R,S) to the output line, so it will work as 4-to-1 multiplexer.

54. Ans. C.

In push operation 3 cycles involved: 6T+3T+3T = 127

POP operation 3 cycles involved: 4T+3T+3T = 107

So in the opcode fetch cycle 2T states are extra in case of push compared to POP and this is needed to decrement the SP.

55. Ans. B.

Sol. In this first we need to find the break point by finding the root of $\frac{dk}{ds} = 0$ and then by using magnitude condition value of k can be obtained.

$$G(s) = \frac{K}{s^2 + 5s + 5}$$

$$k = -(s^2 + 5s + 5)$$

$$\frac{dk}{ds} = 0$$

$$\Rightarrow 2s + 5 = 0 \Rightarrow s = -2.5$$

Applying magnitude condition $\left|G(s)\right|=1$

$$\left|\frac{K}{s^2+5s+5}\right|_{s=-2.5}=1$$

$$\Rightarrow\left[\frac{k}{(-2.5^2)+[5x(-2.5)]+5}\right]=1$$

$$\Rightarrow\left[\frac{k}{6.25-12.5+5}\right]=1$$

$$\Rightarrow\left|\frac{k}{-1.25}\right|=1\Rightarrow k=1.25$$

56. Ans. A.

K = 2.86

Peak over shoot 10%

$$\Rightarrow e^{\frac{-\pi\xi}{\sqrt{1-\xi^2}}}=0.1$$

$$\Rightarrow\left[\frac{-\pi\xi}{\sqrt{1-\xi^2}}\right]^2=[In0.1]^2$$

$$\Rightarrow\frac{-\pi\xi}{\sqrt{1-\xi^2}}=\left[\frac{\pi}{In0.1}\right]^2$$

$$\Rightarrow\frac{1}{\xi^2}=1+\left[\frac{\pi}{In0.1}\right]^2$$

$$\Rightarrow\frac{1}{\xi^2}=2.86$$

$$\Rightarrow\xi^2=\frac{1}{2.86}=0.34$$

$$\Rightarrow\xi=0.59$$

$\rightarrow$The characteristic equation of above transfer function is $s^2+2s+k=0$ Comparing with standard equation $s^2+2\xi\omega_n+\omega_n{}^2=0$

$$\Rightarrow 2\xi\sqrt{k}=2$$

$$\Rightarrow\sqrt{k}=\frac{2}{2\xi}$$

$$\Rightarrow k=\left[\frac{2}{2\xi}\right]^2=\frac{1}{\xi^2}=2.86$$

$$k=2.86$$

57. Ans. A.

We can proceed here by taking this polynomial as characteristic equation and conclusion can be draw by using RH criterion. As we are interested to know how many roots are lying on right half of s plane.

S^4	2	0	-2
	-5	+5	0
		-2	$\left\{\begin{array}{l}\text{Since row of zero}\\ \text{occurs the}\\ \text{auxiliary equation}\\ \text{is}\end{array}\right.$ $A.\varepsilon: 2s^2-2$ $\frac{d}{ds}(At)=4$
	4	0	
s	-2		

$\rightarrow$The number of roots i.e. the number of zeros in this case in right half of plane is number of sign changes

$\rightarrow$Number of sign changes = 3

58. Ans. A.

$$\sum_{i=1}^{\infty}\left(\frac{1}{2}\right)^i\log_2(2)^i=\sum_{i=1}^{\infty}\left(\frac{1}{2}\right)^i\log_2{}^2$$

$$=\sum_{i=1}^{\infty}i\left(\frac{1}{2}\right)^i$$

$$=\sum_{i=1}^{\infty}ia^{i-1+1}=a\sum_{i=1}^{\infty}ia^{i-1}=a\sum_{i=1}^{\infty}\frac{d}{da}(a^i)$$

$$=a\frac{d}{da}\left[\sum_{i=1}^{\infty}a^i\right]=\frac{a}{(1-a)^2}=\frac{1/2}{1/4}=2bits$$

59. Ans. A.

Cross over Probability P= 0.1

X = number of errors

$$\frac{1}{2}P(x\geq 2|_{000sent})+\frac{1}{2}P(x\geq 2|_{111sent})$$

$$=2\times\frac{1}{2}\left[\left(\frac{3}{2}\right)(0.1)^2(0.9)^1+\left(\frac{3}{2}\right)(0.1)^3(0.9)^0\right]$$

$$=3(0.01)(0.9)+(0.3)^1=\frac{27}{1000}+\frac{1}{1000}=\frac{28}{1000}$$

$$=0.028$$

60. Ans. A.

$$r(t) = S(t) + n(t)$$

$$r_s(t) = \int_0^t s(u)h(t-u)\,du$$

$$r_n(t) = \int_0^t n(u)h(t-u)\,du$$

$$SNR = \frac{Y_s^2(t)}{E[Y_s^2(t)]} = \frac{\left[\int_0^t s(u)h(t-u)\,du\right]^2}{\frac{N_0}{2}\int_0^t h^2(t-u)\,du}$$

$$By\ CS\ in\ equality\ \left(\ if h(t-u) = CS(u)\right)$$

$$SNR_{opt} = \frac{\int_0^t s^2(u)\,du}{\frac{N_0}{2}} = \frac{2E_s}{N_o}$$

$$SNR_{opt} = \frac{2E_s}{N_o}\ \ if\ \ E_n \geq E_s$$

61. Ans. D.

Current density,

$$\vec{J} = \frac{400\sin\theta}{2\pi(r^2+4)}\bar{a}_r\ A/m^2$$

current passing through the portion of sphere of radius r = 0.8 m is given by

$$I = \int_s \vec{J}.d\vec{s}\ (r = \text{constant})$$

$$d\vec{s} = r^2 \sin\theta\, d\theta\, d\phi\, \hat{a}r\ d\ (\because\ r = 0.8\ m)$$

$$I = \int_{\theta=\frac{\pi}{2}}^{\frac{\pi}{4}} \int_{\phi=0}^{2\pi} \frac{400\sin\theta}{2\pi(r^2+4)} r^2 \sin\theta\, d\theta\, d\phi$$

$$= \frac{400(0.8)^2}{2\pi(0.8^2+4)}\left[\left(\frac{\pi}{4}-\frac{\pi}{12}\right)-\left(\sin\left(\frac{\pi}{2}\right)-\sin\left(\frac{\pi}{6}\right)\right)\right]\times(2\pi)$$

$$\therefore I = 7.45\ \text{Amp}$$

The average current density through the given sphere surface is

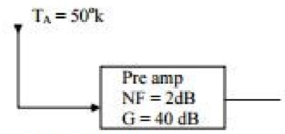
$$J = \frac{I}{\text{Area of } r = 0.8\text{m sphere}}$$

$$= \frac{7.45}{(0.8)^2 \int_{\theta=\pi/2}^{\pi/4} \int_{\phi=0}^{2\pi} \sin\theta\, d\theta\, d\phi}$$

$$= \frac{7.45}{1.04}$$

$$\therefore J = 7.15\ A/m^2$$

62. Ans. A.



$10 \log_{10} NF = 2dB$

$\log_{10} NF = 0.2$

$NF = 10^{0.2}$

Noise temperature $= (F-1)\,T_o$

$= (10^{0.2} - 1)\,290o = 169.36$ K

Noise power i/p $= k\,T_eB$

$= 1.38 \times 10^{-23} \times (169.36 + 50) \times 12 \times 10^6$

Noise power at o/p $= (3.632 \times 10^{-14}) \times 10^4$

$= 3.73 \times 10^{-10}$ watts

63. Ans. A.

Given Lossless horn antennas

$\eta T = \eta R = 1$

Power Gain = Directivity

Directivity of Txing antenna, $D_T = 18$ dB

$10 \log D_T = 18$

G_T (or) $D_T = 63.09$

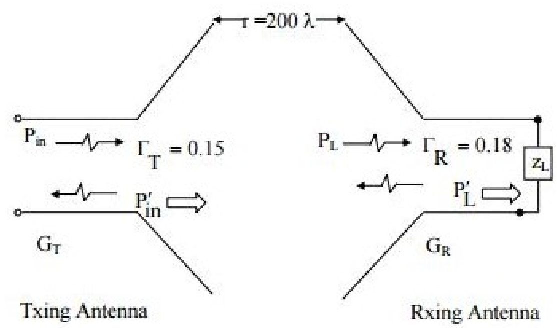
Directivity of Rxing antenna, $D_R = 22$ dB

$10\log D_R = 22$

G_R(or) $D_R = 158.48$

input power $P_{in} = 2$ W

Spacing, $r = 200\ \lambda$



Friis transmission formula in given by

$$P_L = G_T G_R \left[\frac{\lambda}{4\pi r}\right]^2 P'_{in}$$

where:

P'_{in} : Input power (prime indicates power due to reflection)

$$P'_{in} = \left|1-\Gamma_T{}^2\right|P_{in}$$

$$= \left|1-(0.15)^2\right|\times 2$$

$$P'_{in} = 1.955\ W$$

$$P_L = 63.09 \times 158.48\left[\frac{\lambda}{4\pi\times 200\lambda}\right]^2 \times 1.955$$

$$= 3.1 \times 10^{-3}$$

As there is a reflection at the terminals of Rxing antenna power delivered to the load in given by

$$P'_L = \left\{1-\left|\Gamma_R{}^2\right|\right\}\times P_L$$

$$= \{1-(0.18)^2\} \times 3.1 \times 10^{-3}$$

$$\therefore P'_L = 2.99\,mW$$

64. Ans. C.

Given

Electric field of incident wave is

$E_W^i = (\hat{a}_x + j\hat{a}_y)E_0 e^{jkz}$

at $z = 0$;

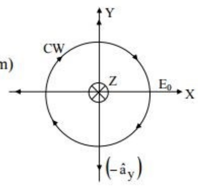
$\vec{E}_w^i = E_0 \cos\omega t\, \hat{a}_x - E_0 \sin\omega t\, \hat{a}_y$ (in time varying form)

at $\omega t = 0$

$\vec{E}_w^i = E_0 \hat{a}_x$

at $\omega t = \frac{\pi}{2}$

$\vec{E}_w^i = E_0(-\hat{a}_y)$



As a tip of electric field intensity is tracing a circle when time varies, hence the wave is said to be circularly polarized in clockwise direction (or) RHCP. Polarizing vector of incident wave is given by,

$\hat{P}_i = \frac{\hat{a}_x + j\hat{a}_y}{\sqrt{2}}$

radiated electric field from the antenna is

$\vec{E}_a = (\hat{a}_x + 2\hat{a}_y)E_1 \frac{1}{\gamma} e^{-jk\gamma}$

at $r = 0$

$\vec{E}_a = E_1 \cos\omega t\, \hat{a}_x + 2E_1 \cos\omega t\, \hat{a}_y$ (in time varying form)

As both x & y components are in-phase, hence the wave is said to be linear polarized. Polarizing vector of radiated field is $\hat{P}_a = \frac{(\hat{a}_x + 2\hat{a}_y)}{\sqrt{5}}$ polarizing mismatch; The polarizing mismatch is said to have, if the polarization of receiving antenna is not same on the polarization of the incident wave. The polarization loss factor (PLF) characterizes the loss of EM power due to polarization mismatch.

$PLF = |\hat{P}_i . \hat{P}_a|^2$

in dB; PLF (dB) = 10 log (PLF)

$$PLF = \left|\left(\frac{\hat{a}_x + j\hat{a}_y}{2}\right) . \left(\frac{\hat{a}_x + 2\hat{a}_y}{\sqrt{5}}\right)\right|^2 = \left|\frac{1 + j2}{\sqrt{2}\sqrt{5}}\right|^2 = \frac{1}{2}(\text{or})0.5$$

$$PLF(dB) = 10 \log 0.5 = -3.0102$$

65. Ans. B.

$$P_{rad} = \int_{\theta=0}^{\pi/2} \int_{\phi=0}^{2\pi} W_{rad} r^2 \sin\theta d\theta d\phi$$

$$= \int_{\theta=0}^{\pi/2} \int_{\phi=0}^{2\pi} \frac{C_0}{r^2} \cos^2 \omega r^2 \sin\omega d\theta d\phi$$

$$= C_0 \times \left.\frac{-\cos^2\theta}{5}\right|_0^{\pi/2} .2\pi = \frac{2\pi}{5} C_0 = 1.256 C_0$$

$$Max.\ directivity\ = \frac{\max(W_{rad})}{P_{rad}} \times 4\pi r^2 = \frac{4\pi}{1.256} = 10$$

$$Max.\ Directivity\ in\ dB\ = 10\ log\ 10\ = 10\ dB.$$

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